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Abstract

Advances in computing and communications capabilities are becoming widely available to groups to help them to do their work. The development of these systems has primarily grown out of new technologies and not from an understanding of the assignments groups are asked to complete. We believe that an in-depth understanding of the complex tasks that groups are frequently assigned is necessary to realize the full capabilities of new technologies. In this chapter, we focus on groups which face the highly interactive and complex task of developing new products and present a description of the activities in which these teams engage and move from that data to suggest how information technology might better be used to support the work of those teams.

Information Technology and Work Groups:

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The Changing Role of Groups in Organizations

Today, task forces and project teams are performing tasks that might formerly have been handled through an organization's formal structure or assigned to individuals. Whether it is the establishment of product development teams at General Motors or Proctor and Gamble, quality circles at Lockheed, or groups to implement new manufacturing strategies in the aerospace industry (Kazanjian & Drazin, 1988), the use of teams is expanding rapidly (Goodman, 1986) because they are believed to increase individual commitment and performance, thus shortening the time necessary to bring a new product to market and thereby increasing competitiveness (Hackman & Walton, 1987; Kanter, 1986). Groups are also formed out of necessity; as products and technologies become more complex, what once could have been done by an individual may now require the input and experience of a number of individuals. Similarly because important decisions involve many constituencies, the use of teams broadens participation in decision making, thus increasing commitment to the decision (c.f. Coch & French, 1948; Janis & Mann, 1977).

Although groups have always been an important tool for accomplishing organizational goals, the form and usage of groups differs from the past. One area of difference is in the increased amount of authority and responsibility granted to the team (Galbraith, 1982; Kanter, 1983). In response to international competition and the

accelerating pace of technological and market change, organizations have attempted to become more flexible and adaptable. One way to do this is to push decision making down the organizational hierarchy, assigning the freedom and responsibility to respond to threats and opportunities to task forces and project teams. However, when group projects and goals are generated from within rather than assigned from above, the group bears a special burden; because it lacks administrative approval for its actions, it must work to find support for its ideas within the organization.

A second way the use of groups is changing is in how individuals are assigned to them. Rather than permanently assigning individuals to work groups with a fixed task or set of tasks, the norm is often to assign individuals to work part-time on multiple projects. These groups are often temporary and have membership that changes over time; they are made up of individuals who must work closely together for a short period of time while simultaneously carrying on other individual or group work, and maintaining commitments and loyalties to other parts of the organization.

A third factor that differentiates the new form of groups from others is cross-functional composition or orientation. To respond to competitive challenges, organizational units often have to be more closely coupled than in the past, sometimes even working in parallel to complete assignments that span traditional organizational units (Clark & Fujimoto, 1987). Thus, individual work group members must interact extensively with others who are not team members. The group can no longer be seen as a bounded unit; rather it must be viewed as an open

system interacting with other groups and individuals in the organizational environment.

At the same time as the use and form of organizational groups is changing, advances in computer science and information technology offer new techniques that can influence the processes and performance of a group. In recent years not only have large numbers of employees acquired access to computers, but the ability to connect computers to each other has created the potential for altered patterns of communication and coordination. For instance, teleconferencing allows for multiple individuals in geographically dispersed locations to hold meetings, group decision support systems have been designed to enhance the decision making ability of groups through procedures that structure the weighting of alternative solutions (Kraemer & King, 1986), and CAD/CAM systems can be used to help people display and manipulate technical information more effectively in face-to-face meetings. Finally, as the other chapters in this volume indicate, "groupware" of various kinds is continually being developed to support collaborative work (Abel; Lakin; Landow; Olson & Atkin, this volume).

These new technologies may significantly affect the way group members work with each other and with other parts of the organization. What is less clear is whether the nature and role of these new technologies will depend solely on the intuitions of systems designers or will be guided by a coherent theory of how people must coordinate their activities to complete group tasks (Malone, 1987).

Developing More Complete Theories of Groups

To keep pace with these changes, conceptual analyses of groups

need to take into account the specific things groups must do and how group members must interact with individuals outside the group to complete their assignments. This contrasts to what is the more typical approach of relying on simple models of group tasks and focusing exclusively on interactions within the group.

An understanding of the specific task a team must perform can lead to the development of a fuller model of group process and allow for a more complete definition of team performance (Goodman, Ravlin & Schminke, 1987) than normally used and therefore eliminate many of the conflicting findings common in group research (c.f. Gresov, 1988). It is our contention that only group research that begins with a clear understanding of the team's task can lead to useful theories of how people must coordinate and thus guide the development of improved information technologies.

Since teams and task forces must both draw resources from the organization and give back to the organization the results of their efforts, we believe that models of group activities must include both the things team members do with one another and those things that are done with people outside the group. This approach contrasts with many theories of groups with focus almost exclusively on the processes and activities that occur inside the group. There is a long history of lumping the critical activities of a group into those related to accomplishing the task and those contributing to the maintenance of the group (Philip & Dunphy, 1959; Schein, 1988). Research growing out of this tradition has led to a good understanding of individual behavior in groups (c.f. McGrath, 1984), communication among group members

(Putnam, 1986), the phases groups go through (Tuckman, 1965; Gersick, 1988), and how groups make decisions (c.f. Bettenhausen & Murnighan, 1985). It has not, however, led to a clear understanding of how groups deal with others, including how the group obtains the resources necessary to complete its task and gains support for the results of its efforts.

Recently, a number of studies have started to explore communications between work groups and the environment in which they exist and to examine the impact of these communications on group performance. For example, in investigations of research and development laboratories, the amount of external communication with other parts of the organization has been positively related to performance (Allen, 1984; Katz & Tushman, 1981; Tushman, 1977, 1979). Bringing information into the group is only one way the group interacts with other groups. In an earlier paper (Ancona & Caldwell, 1988) we described a broad model of the types of activities in which groups engage to manage their dependencies with others including how the group defines its membership, how the group manipulates the permeability of its boundary, and how the group attempts to obtain information and resources from its environment.

These observations have led us to conclude that theories of groups in organizations be more useful if they incorporate information about the group's task and consider both internal processes and the way the group deals with others. Furthermore, we posit that if information technologies are to be used to improve the performance of highly complex teams, they must be designed with a clear understanding of the

communications and task activities that take place within the group as well as those between groups members and outsiders. To provide a part of that foundation, we describe here part of our observations of new product teams, one exemplar of the type of group that is assuming increasing importance in organizations.

These teams are responsible not only for the specific technical design of a product, but also for coordinating the numerous functional areas and hierarchical levels that have information and resources necessary to make the new product a success. Team members may be assigned to the team full-time or may be only part-time participants. Similarly, members may remain on the team from inception to finish, or may terminate membership after some portion of the task is completed. Given these characteristics the new product team provides an ideal model of the ad hoc task group,and is therefore a useful model for thinking about how information technology might be used to assist teams who must manage dependencies on other organizational entities to carry out a complex collaborative task.

In the remainder of this paper, we will describe the task of the new product team and some of the activities through which these teams complete their work, concentrating on how the team interacts with others to complete its assignments. We will then outline how information technology might be designed to help these groups carry out their work.

The Task of the New Product Team

Our observations about the complex tasks faced by new product

teams are based on data drawn from a study of the product development process in high technology companies. The conclusions we present are based on data collected during interviews with the managers of new product teams at seven corporations in the computer, integrated circuit, and analytical instrumentation industries. We interviewed 34 new product team managers whose teams were at various stages of the product development process. The interviews were semi-structured and ranged from one to eight hours, with an average length of approximately three hours. We asked each manager to describe, in detail, the activities he and the other members of the team carried out, both within and outside the group; we asked each to discuss shifts in team activities over the product development process and to describe stumbling blocks that impeded progress. In addition, we interviewed four managers who were responsible for supervising multiple teams. These managers were asked to describe patterns they had observed and differences between teams. The interviews were taped and transcribed, and the transcriptions were evaluated to identify patterns of activity and transitions in the product development process. In addition, fifteen new product team members were asked to keep a log in which they described their interactions as they worked to complete their tasks. This sample is neither representative nor large enough to test specific hypotheses. Rather, our goal is to describe the task and processes of the new product team, thereby augmenting the normative literature with observations from the field.

For most of the teams we studied, the new product team managers described a general pattern in which two events served to divide the

process and direct the new product team's activity. We refer to these events as transition points because they mark major shifts in the activities of team members; they divide the product development process into three phases which we label: creation, development, and diffusion. The first transition point represents a shift from a "possible product" to "definite product." The second involves a transfer of the technology and product ownership from the new product team to others in the organization. For many teams, these transitions represent major challenges to the viability of the group.

Our interviews suggest that each phase and transition point requires different patterns of team functioning and different patterns of interaction with outsiders on the part of the new product team. Below, we illustrate the nature of these phases and transition points with excerpts from many of our interviews and summarize a wider range of activities found across the teams.

The Creation Phase

> The first thing I did was to go to talk to lots of people to find out what they thought the product was and how to get there. This was at the technical level, what are the details, not just global suggestions. I started out with the guy who brought me here, he sent me to see someone else, and so it went that I came to talk to a lot of high- and middle-level people. The interviews were open-ended but I pushed and maybe even taught them a few things about their concept; what it meant to produce the product they envisioned. So I gained knowledge about details of what the product ought to be, who the players were, what they did, and what they wanted.
>
> It's not exactly clear how the whole thing got started, but then it seldom is. There were these two other projects going on, but they weren't doing too well. So, about a year ago the Product Committee decided to start this new project. We started out by having a meeting with the two old project teams, and members of the top corporate and division management. This was May and we were supposed to have this wonder machine ready to ship by January. After the two former leaders were signed up for the

> project I pulled in two more key people and had an initial meeting. This was the core of the group. We added a few more people and then spent a couple of weeks frittering about, reading stuff, deciding if the product was feasible. People were saying 'no way it can happen' and I was busy setting things up so we'd have a place to live. We moved in and launched into work.

Our interviewees typically reported that they talked frequently with people outside the team in this early phase. The topics of most of these interactions fell into one of three categories: Collecting information or resources, modeling the organizational environment, and building links with other groups. They collected technical information about what was and was not feasible and what the latest innovations had been, market information about what products were selling well and what the competition was doing, and political information about who supported the project and who did not. In addition to collecting information, they attempted to create models of how other groups would respond to the product. This included forecasts of top management's response to the product concept or potential "snags" which might occur in the future. Finally, team leaders' reports suggest that the new product teams also developed communication links with other groups who did not have information or resources currently needed by the team. Many of these contacts were undertaken in anticipation of a later phase, when the cooperation and support of the target groups would be needed. In other cases, these efforts to build communication links involved trying to shape outside opinion to make it more favorable towards the team.

However, not all of the new product teams' activities were externally oriented; there was a great deal of interaction among team members as well. Product definition was a clear priority, particularly

the process of moving from a very general idea to a specific design plan. One manager described this phase as "playing in the sandbox"; members were occupied with exploring various ideas and determining feasibility (See Kraut, Galegher & Egido, 1988 for a similar description of intellectual play in the project initiation phase of collaborative research.). This preceded the difficult job of selecting the best of the alternatives that had been examined.

During this phase, the membership of the team stabilized, and internal patterns of interaction developed and began to formalize. The task of the group at this time is one of defining the product, determining its feasibility, and organizing to become a working team.

Possible to Definite Project: A Transition Point

> The design review was set up to make sure we weren't going off in crazy directions. All of R&D was invited, quite a few showed up. We had answers to most of their questions, and we got lots of helpful input. We were official now, they had given us the OK. We went back to work.
>
> The first sell was to the R&D staff. We had decided what we wanted to do and we had to get them to agree, the VPs had to sign off. We're spending their money, we have to meet their needs to keep getting resources. We got lots of comments. Then we had to present our responses to their comments at another meeting with a broader audience. We were seeking the blessing of top management.
>
> Management just couldn't all get together and decide which chip they were going to use. It was debated and changed and debated and we couldn't really get working. The cost and time to delivery got out of control. We had to scrap the whole thing and most of the team left the company.

Our interviews suggest that the first transition point occurs just prior to the major portion of the development phase and involves a shift from recognition of potential feasibility to commitment to one new product idea. This entails movement from low-cost effort with minimal organization support to major capital investment and support

from top management. In our sample there was usually some formal, organizationally imposed, design review that forced the new product team to present and defend its design. Even when this was not the case, there was usually informal organizational pressure about this time to brief top management and get their support. Team leaders describe spending a great deal of frenzied time and activity preparing for these reviews, be they formal or informal.

Three of our interviewees reported difficulties with this transition. Two described teams that failed to get agreement with and the support of other groups and could not progress. The third described a team whose members could not agree among themselves about certain technical issues. These groups could not build both internal and external consensus on project specifications, hence they could not move from the process of deciding what the product should be to deciding how to actually make the product. Our interviewees generally reported a shift in activities in the teams that successfully completed this transition point. The general task of the team moved from defining the new product idea, determining feasibility, and gaining support for it to actual product development.

Development

> There was a lot of coordinating to do. I wanted to make sure they had ordered the components and the printed circuit boards. George was the liaison to manufacturing, but I needed to check on things once in awhile. As time went on there was so much to watch over that we decided to bring in three people from manufacturing. They helped with the components decisions: which could be obtained, did they have the right performance specs. At this point we also started meeting with people outside the group to provide a status update. We had representatives from purchasing, larger manufacturing areas, production planning, diagnostics and marketing. We informed them of progress and changes and published the meeting minutes on-line so everyone could access them. We also kept the

Product Committee informed.

> By November the top committee was getting panicky: they were nice, but they were nervous. I tried hard to protect the team from the pressure, but the rest of the company was like a pressure cooker. Some of the team even had to come in during Christmas time. The machine just wasn't working and everybody felt as though we'd failed, even though we'd done the impossible. Still we were late to Manufacturing and everyone was scared.
>
> Several rules are in place now, such as minimizing new technology so that this thing gets out in time. Now for every piece of the product we have a plan and every Monday morning people had to report on where they are with respect to this plan. I'm in the middle of two ends of a problem. From above I get major direction and goal setting, like we really don't want to deliver in February but in December, and then Monday mornings I get reality.
>
> I decided to house us in an isolated building. This was a novel task, there were lots of new people, and we were going to be going hard and fast. That kind of intensity has to be isolated. Besides, if people aren't together the project isn't going to turn out as good as it could have. People who are working have two things to do. One is they have to do the operating system for the project. The other is they have to stay in touch with the rest of the organization, so they are torn. I want people to make project optimizations not local ones.

Many of our interviewees described the type of dilemma illustrated in the final quotation. The development stage requires that the team focus much of its effort internally, on technical issues. However, team leaders also reported that substantial efforts were needed to maintain and build relationships with other groups.

In this phase, the team needs to spend its time on technical development; therefore, it can not be interrupted constantly. An important dilemma that team leaders talked about is how much separation there should be between the team and the rest of the organization. Specifically, should the team obtain separate facilities or perhaps even physically isolate itself from the rest of the organization? Isolation allows the team to focus on technical innovation and speed

but may make it difficult for the team to carry on transactions with other functional groups. Within the group, this stage requires the highest need for close coordination among team members and most teams appear to work out routines and methods for accomplishing this.

Isolation allows the group to shift its activities. During the development phase, the team must move from product definition to setting goals and schedules for actual development. For this to be done, inputs from others regarding their priorities and suggestions for the product design need to be restricted unless market or competitive information radically changes. This restriction may be difficult to maintain since other functional groups may view the product as a concept that is open to constant change and updating (Dougherty, 1987). Isolation can facilitate information restriction. Groups that are unable to restrict this information may lose valuable time and suffer reduced effectiveness. The potential importance of this isolation was illustrated in that two of the three of the team leaders who informed us that their teams failed at this stage, reported continually changing work goals and schedules in response to new information and inputs to be the cause of the failure.

Although, during this stage, the group's priorities change to managing its internal activities, our interviews indicate that in the development stage there is still a need to manage team activities and relations with others. The focus of the team is on using the resources and information previously obtained to develop the product, yet the group must begin to coordinate with other functional groups to ensure that they will provide components and take over the product at the

agreed upon time. During this time, top corporate management needs to be informed of the product's progress as well.

Technology Transfer: A Second Transition Point

> Then we had this big fight. Manufacturing said let's build it and make repairs later: Engineering said let's hold it. I was in the middle. Manufacturing yanked these people out. I was in a tenuous position. I wanted the product to stay with the team to get the bugs out but the product committee and the rest of the organization were going crazy. We had made a deal with some customers. There were huge pressures to get it over to manufacturing.
>
> DECLARATION OF IMPATIENCE: A time has come, we believe, to call a halt to product XX engineering and ship the product. We believe it is time to say IT'S DONE!!! Put the unfinished business on the shelf for product 2XX. This product already is the best on the market, by far, and the momentum of things to come will insure that it stays that way. BUT NOT IF IT DOESN'T SHIP! We sell the customer on evolution, not on a solution for all men, for all time, now. Get on with the final game. NO MORE DEVELOPMENT!!! (Memo sent to a new product team by one team leader)

A second transition point normally occurs somewhere during the testing phase. In most cases, technological problems have been assessed and a prototype exists and has been tested. The transition consists of moving from team ownership of the product to more general organizational ownership. Our interviewees report a change that is similar to what Quinn and Mueller (1963) call a technology transfer point where the emphasis moves from developing the technology to passing information, enthusiasm, and authority to use that technology to other groups in the organization. Our interviewees report that this transition will not occur if the group is either unwilling to relinquish the product or unwilling to continue to work on the product when it has passed into the hands of others.

This was a difficult transition for all the teams described to us. Problems ranged from members who were unwilling to transfer the product

to others, to less committed team members who began work on other projects, leaving the project before a smooth transition to manufacturing occurred. For most teams, this transition signaled a decrease in the isolation and commitment of team members. Many interviewees reported a shift in team activities from internal team decisions to "selling" the product idea to other groups.

Diffusion and Ending

> The team now has a whole different form. Those who are helping manufacturing are spending most of their time in New Hampshire at the factory. That is a small subset of the original team. Some of the team members are busy going over documentation and support products. There are still a lot of other groups that have to come through for us to make this product shine. Then there were quite a few people who left when their part of the project was done. There are a few who have stayed on along with some new people to work on the third generation. This is sort of a transition from one team to another.
>
> At this point, the team wasn't meeting much. People didn't seem to know what to do. It was the end of an intense group. People were burnt out. People were zombies. People weren't ready to start over. They hadn't recovered. Maybe I should have been doing some career planning but that's not really what I wanted to do. People were lost but the product was great. I sent all my people on vacation.

Our interviewees reported that during the diffusion phase the external activities of their teams increased dramatically as members began transferring technical data as well as a sense of ownership to other groups that must manufacture and market the new product. The necessity of transferring product ownership causes some obvious difficulties for a team. Some interviewees reported that the nature of the second stage of the development process, particularly if the team has isolated itself, caused teams to develop a very impermeable boundary. Although the isolation this boundary created may have been important in facilitating the internal decision making and group

cohesiveness necessary during the second stage, it occasionally made the product transfer difficult.

The team leaders reported that variability of individual involvement in completing the product was high at this stage. The key issue was keeping those members needed to finish up the project committed to it, while moving those whose efforts were no longer needed on to other activities. A number of team leaders mentioned that balancing these responsibilities was difficult. Maintaining motivation was difficult because the major product development decisions had already been made and what remained was completing product details and transferring the product to other groups.

Dominant Task Activities Within Phases

In sum, our interviews suggest that new product teams follow a pattern as the product development process proceeds. We found three phases of activity: creation, development, and diffusion. Each phase can be described in terms of a dominant task requirement, and each of these task requirements demands different patterns of interaction among team members and between the team and outsiders.

During the creation phase the team must obtain the information and resources it will need initially and in the future. The main task requirement for the team at this time is exploration. Teams must determine what resources are available to them, what the product can and should be, and what the other areas of the organization want the product to be. In addition, teams must explore the technologies available for building the product and the markets it might serve at this time. Exploration inside the team involves getting to know other

team members, determining who has particular skills, and who can be trusted.

Teams then face a difficult transition as they move from exploration of numerous alternatives to commitment to a specific product design. The dominant task requirement following this transition is the efficient exploitation of the information and resources the team has collected. To develop the product in the form that was agreed upon, the team must solve technical problems and learn to operate efficiently. Externally the team moves from gathering information and determining others' expectations for the new product to coordinating, keeping others informed, and building relationships with the groups that will receive the team's output.

Following a second transition, the emphasis for the team becomes that of exportation of its product to others. As the team transfers ownership of the product to others, the emphasis on smooth, efficient internal operations declines and the emphasis on external relations characteristic of the creation phase recurs. To make the development process a success, the team must export not only the product, but a sense of excitement and commitment to the other groups who will be responsible for marketing, manufacturing, and servicing the new product. Thus, in this stage, the team shifts to working intensively with members of these other groups.

Two general conclusions can be drawn from our interviews. First, product development demands a complex pattern of group activities and interactions that change over time and what is necessary for the group to do at one time is detrimental to accomplishing the task at another.

Second, a model of the group process of the new product team requires an understanding of both the interactions among the team members and how the group members deal with outsiders. We believe that clear, complete models of group behavior can facilitate the design of effective information technologies.

Issues in Designing Information Technologies that Fit Group Task Requirements

The task requirements of exploration, exploitation, and exportation require different patterns of interaction both among team members and between the team and outsiders. Therefore, information technology to support groups, such as new product teams, must facilitate very diverse patterns of interaction. To aid the group with internal and external task requirements, and with shifting from one type of activity to another information technology must have a great deal of flexibility. As the interactions required of team members change, computer-based communication and decision support systems must facilitate adaptation to the new set of demands. If they do not, they may disrupt the group's progress by encouraging it to retain familiar modes of working that are no longer appropriate. Below, we draw out the implications of our observations for the design of computer applications to support these varied tasks. However, we hasten to point out that our expertise is in the analysis of social behavior; thus, our ability to make detailed recommendations in this domain is limited. This shortcoming on our part only serves to emphasize the central theme of this book — that behavioral scientists and systems designers live

in separate worlds and that many more researchers who speak both languages are needed to bring the worlds closer together.

Exploration

One key aspect of exploration is modeling, or creating a "picture" of the external environment including predictions of where resources can be found, who supports the team's efforts, and what expectations others hold for the team. There are a number of ways that information technology could potentially be applied to helping the group model its environment. For example, a program could be developed to supply the team with organization charts showing relevant parts of management, manufacturing, marketing, and other functional areas. Team members could then work together to mark in some way those people who have relevant resources, those who support the team and those who do not, and to define others' expectations of the product. Perhaps most importantly, members could also mark those individuals whose views are currently unknown by the team. This mapping process could then automatically generate responsibility charts that would structure the group to fill in gaps of knowledge, direct it to plan meetings with outsiders who need to be encouraged to help, or help it decide which expectations it can realistically meet. Although not yet commercially available, the Stakeholder Identification and Assumption Surfacing described by Vogel and Nunamaker (this volume) is a useful prototype of this sort of software.

Exploration also involves exploring ideas and possibilities for the new design. Computer applications could help the team keep track of its ideas, increase creativity, and evaluate its work. For example,

one of the teams in our study was struggling to decide how compatible with other computers the computer they were designing had to be. Information technology could provide a structure to list current options, and to prompt for brainstorming of additional ideas. Team members and outsiders could then be asked to set criteria for choosing among the options. Prompts would be programmed to assure that issues of manufacturability, commercial potential, and finance would be considered. This setting of criteria might also point out areas where more information about the options would need to be gathered. Then team members and outsiders would be asked to rate each option and the ratings would be displayed to present areas of agreement, areas of disagreement, high scoring options and low scoring ones. After discussion of the data the process could be repeated until consensus built around one option. Later, this same process could be used to get feedback from external groups on the design.

Exploitation

During the development stage the primary task requirement is exploitation of information and resources to achieve efficient internal operations. Information technology could facilitate coordination among group members, forecasting of schedule delays, and external reporting of team progress. By focusing on internal progress and coordination, this technology could help the group shift its emphasis away from exploration.

Some of the teams in our study designed their own PERT charts to track what each team member had to have ready at a particular time; this procedure is very complex and could easily be simplified generic

scheduling programs. Systems dynamics modeling has been developed that will forecast the impact on commercialization schedules of a delay in the production of a major component. Providing team members with this capability would both help them to forecast revised schedules, and communicate the enormous effect that an early slippage can have later in the process. Finally, electronic mail systems could be used to facilitate communication within the group and supplement face-to-face coordination devices with those outside the group.

Exportation

The final set of tasks requires the team to export ownership of the product to those responsible for manufacturing, selling, marketing, and servicing the new product. This exportation is difficult because the team is often competing with other teams for organizational resources and these other groups do not understand, or feel committed to the product. Information technology can aid in product transfer both by preparing other groups for the new product in advance of the transfer date and by facilitating the actual exchange. Tools such as computer conferencing and electronic mail can allow the team to regularly brief other groups during product development and build the knowledge and support of other groups well in advance of the exportation of the product. Such systems could be designed to prompt team members to update other groups on specific topics and at regular intervals. Information technologies can also facilitate the direct exchange of the product. At a simple level, CAD/CAM might be used to distribute pictures of the product and ease the communication of technical details across functional barriers. Of greater value could

be the development of expert systems to aid in the documentation of the new product. Such aids could partially automate a task that frequently delays the new product transfer and provide documentation that will allow the development of greater support for the product among those receiving it.

Group Theory and Information Technology

If information technology is to improve group performance while maintaining favorable group dynamics, care must be taken in how the systems are designed and used. We argue that the design of information technology can benefit from an in-depth understanding of behavior in groups; in particular, we claim that information technology designs must be based on an adequate consideration of external, as well as internal interactions, and the shifts in group task over time.

Many of the recent developments in information technology have been designed with an internal perspective on the group; that is they are aimed at improving the processes and interactions among group members. Although this is an extremely valuable goal, such systems may have the unintended consequence of diminishing the group's interactions with outsiders. Two examples may illustrate how this can develop. We were told of one team that developed programs and languages for use on a local area network among team members that were incompatible with a broader organizational network. While this system facilitated and simplified communication among the team members, it made communication with non-members relatively more difficult.

The second example has to do with systems designed to enhance group decision making. Systems have been developed to improve group

decisions by reducing individual biases, speeding up the process, and facilitating interactive decision making — in short, by helping the group improve its internal processes. Although extremely useful under many circumstances, such decision aids may lead group members to view themselves as a closed system. If this happens, the group may not work to ensure that information is obtained from external sources and outsiders become committed to what the group produces. Clearly, applications need to be developed to encourage teams to model their dependence on the external organization and to develop ways to meet that dependence.

The second factor important to accomplishing the group task is to correctly map out changing task demands. A clear advantage of most information technology is that it lowers the cost of communication and coordination. Under many circumstances this enhances task accomplishment. For certain tasks, however, the unfiltered flow of information which is useful for a certain period, becomes disruptive as requirements change. One of our interviewees described a team that failed because it was unable to commit to a single design idea. The team would constantly rethink decisions in response to new information, preventing the team from making systematic progress. In this case, the team leader continued to seek input from other groups and use it to redefine the product. If individuals are not sensitive to the information needs of a team, an information system may allow and even encourage the transmission of more data than the team can process. This may become the equivalent of electronic "junk mail."

For all of the benefits of information technology, we must also

realize its limitations. Given the myriad tasks the team must perform, information technology can only support and improve on the performance of some of them. The use of electronic or conferencing systems may aid in the communication of relatively unambiguous information. However, if such systems become the primary communication vehicle the team may reduce its ability to obtain the kind of information communicated through subtlety and nuance. Our data suggest that successful teams are those that are able to build support from others in the organization and ensure that the products they create fit the organization's product strategy. Team leaders indicate that accomplishing these goals is frequently a function of the long-term relationships team members have established with others, the ability of the team leader to "read" the support others are willing to provide the team, and the ability of team members to negotiate with outsiders. Current information technology applications do not have the capacity to allow for such multifaceted exchanges, yet they need to be carried out.

As the responsibilities given teams change and broaden, information technologies provide great opportunities for improving performance. However, to realize the potential of these new technologies, their designers must carefully match the capabilities of the technology to the tasks the group must complete. If this is to happen, new models of group behavior and a clear understanding of the task of the group are necessary. The results of our study of new product teams illustrates the complex nature of the tasks teams will increasingly face. In the case of new product teams, models of effective behavior must describe not only how team members should interact but also how team

members must deal with outsiders. What this suggests is that if information technologies are to improve this type of team's performance, they must be designed to both improve the group's decision making and enhance group members' interactions with non-members.

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